Thesis Proposal

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**Thesis Title:** Entropy-Based Search on Bayesian Optimization

**Objectives:**

**The objective of this thesis project is**

1. Construct entropy-based acquisition functions (i.e., Entropy Search, Predictive Entropy Search and Max Value Entropy Search) that can be used in a Bayesian optimization setting where we use the statistics from a GP posterior distribution to compute the search policy for ES, PES and/or MES.
2. Compare the performance of these acquisition functions in a Bayesian Optimization setting against other common acquisition functions such as probability of improvement, expected improvement, lower confidence bound and / or Thompson sampling.
3. Extend this work to the setting of optimization under uncertainty if time permits where we have Gaussian process models for robustness metrics (optional).

**Description of Activities:**

To achieve these objectives, I will be focusing on:

1. Complete Literature Review on
   1. Gaussian Process Modelling
   2. Acquisition Functions in Bayesian Optimization Modelling
2. Curate multiple datasets in different dimensions in Bayesian Optimization settings
3. Developing implementations for various acquisition functions including:
   1. Entropy-Based acquisition functions:
      1. Entropy Search
      2. Max-value Entropy Search
      3. Predictive Entropy Search
   2. Common acquisition functions:
      1. Probability of Improvement
      2. Expected Improvement
      3. Lower Confidence Bound
      4. Thompson Sampling
4. Testing and evaluating different proposed methodologies in the curated datasets and explore ideas on improving entropy-based search’s performance and efficiency in normal and under uncertainty scenarios.

**Evaluation Breakdown and Percentage：**

Literature Review: 10%

Development and description of theory: 20%

Implementation: 20%

Evaluation: 25%

Summary of Finding: 25%

**Temporary Milestones:**

January 10th – January 24th (Week 1-3):

1. Onboarding with GPytorch and Pytorch by finishing **GPyTorch Regression Tutorial**
2. Complete **2D Gaussian process regression** in GPytorch environment.

**Work Schedule Breakdown:**

For the semester: around 230 hours.

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| Deliverable/ Task | Date/ Time Needed |
| Meeting | Weekly / 1-2 hrs |
| Reading related materials | Weekly / 6 hrs |
| Coding | Weekly / 5 hrs |
| Testing and evaluations | Weekly / 2 hrs |
| Final Thesis Report | A week before the last day of lectures / 40 hrs |